

SPATIO-TEMPORAL MODELING OF AIR POLLUTION INCORPORATING TIME-VARYING METEOROLOGY

Duncan C. Thomas, , *University of Southern California, USA*
Meredith Franklin, , *University of Southern California, USA*
W. James Gauderman, *University of Southern California, USA*

Background and Aims: In the Southern California Children's Health Study (CHS), we have measured ozone and oxides of nitrogen in 942 locations in 12 communities in two seasons for two weeks each, and particulate elemental and organic carbon at 217 locations for two 4-week periods in 8 of these communities. These measurements have been used in combination with various traffic-related predictors to build spatial models for pollution concentrations for all CHS subjects. However, wind patterns and regional pollution levels vary considerably over time and should be taken into account when assigning annual-average exposure levels.

Methods: A theoretical form of the covariance in exposures at different locations as a function of spatial separation and wind can be derived by partial differential equations. We developed a statistical spatio-temporal modeling framework that incorporates the distribution of wind speeds and directions over time and estimates the exposure at unmeasured locations over time, based on concurrent measurements at other locations, the central site measurements, and a line source dispersion model for traffic (CALINE). These estimates are then integrated over time to obtain annual average exposures.

Results: A model that included traffic-related covariates achieved cross-validated R^2 s of 0.60-0.79 for nitrogen oxides, with the major contributor being CALINE; incorporation of residual spatial correlation structure significantly improved model fit. Predictions of particulate EC were much poorer, ($R^2 < 0.3$), indicating that traffic predictors alone are not suitable for all pollutants. Associations with lung function were significantly stronger for spatially modeled NO_x pollution ($p < .005$) than with CALINE predictions or other traffic variables.

Conclusions: Meteorological information, particularly wind speed and direction, improve the predictions of air pollution exposures. Novel ways of incorporating the functional form of winds into the spatial covariance structure of our prediction model are presented.